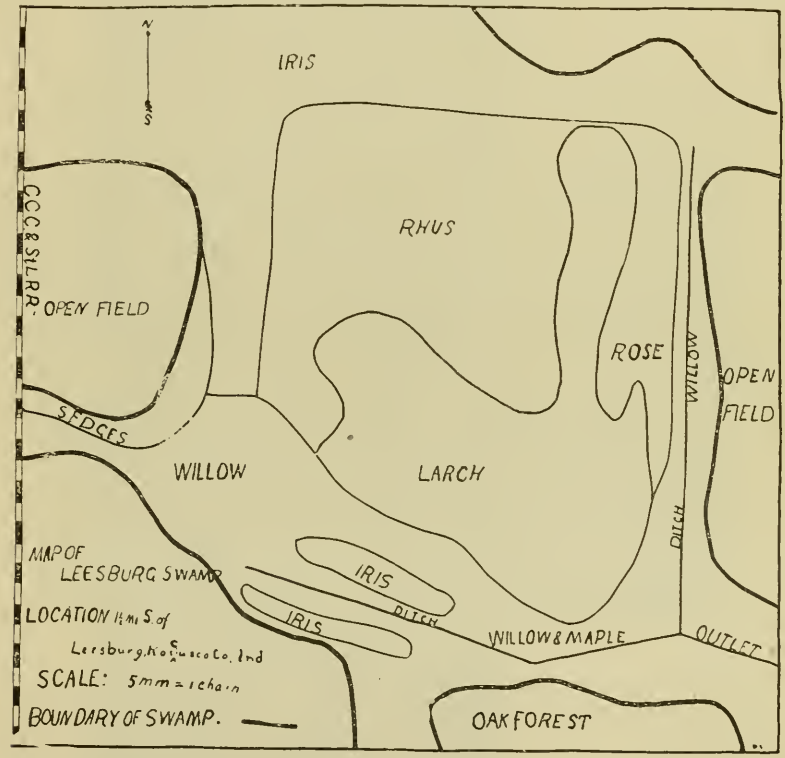
B. The Leesburg Swamp.*

By Will Scott.

Northern Indiana is dotted with lakes and swamps. This land surface is the result of the uneven deposits of the ice sheet and the modification of these by the processes of erosion, sedimentation and plant deposition.



Since the swamp illustrates so well the process through which present conditions came to exist, it was thought worth while to select a typical one, study its flora, physiography and plant depositions, and from these

*Trees of northern United States, by Apgar, was used for the identification of trees. Gray's Manual of Botany (sixth edition) was used for the identification of flowering plants other than trees.

Fig. 1. General view of the swamp (looking southeast). The open cultivated field is a portion of the bottom of the first lake which was exposed by the destruction of the first moraines. The foreground is a sort of bay to the present swamps and was a part of the second lake. The left center is the third lake area and may be distinguished by tamaracks and an intervening belt of Rhus.

things, if possible, determine former conditions and project those yet to be introduced.

The Leesburg swamp was selected. It is located in Kosciusko County, Indiana, one and one-fourth miles south of Leesburg on the east side of the C., C., C. & St. L. R. R. It has an area of 62 acres.

The work was carried on under the general direction of Dr. C. H. Eigenmann, director of the Indiana University Biological Station, and under the immediate direction of Dr. O. W. Caldwell. I wish also to acknowledge the assistance rendered by Mr. W. D. Curtis in collecting, and Mr. A. M. Mahaffey for most of the accompanying photographs.

Fig. 2. Sphagnum.

In this investigation Schimper's[1] division of ecological into climatic factors and edaphic factors was assumed and the edaphic factors only considered.

One of the main purposes has been to test the theories and factors proposed by Warming[2] and Cowles.[3]

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[1]Schimper, A. F. W.: Pflanzengeographie auf physiologischer. Grundlage, Jena 1898.

[2]Warming, E.: Plantsamfund. Copenhagen, 1895.

[3]Cowles, H. C.: The Physiographic Ecology of Chicago and Vicinity. Bot. Gaz., 1901.

Fig. 3. Cinnamon fern. (*Ormunda cinnamomea.*)

The theory of Warming is that all plant societies are determined primarily by the water content of the soil. Cowles accepts the proposition of Warming, but thinks it insufficient because of the fact that there is a wide variation in plant societies which grow in soils having the same water content. His most important conclusion is that plant societies are intimately associated with the physiography of a region and as the topographic forms change from one form to another the plant societies are also modified.

Physiography.

The evidence indicates that this swamp has been a lake or a part of a lake which at consecutive periods has occupied three distinct levels.

The First Lake.—A level plain whose elevation is about eight feet above the level of the swamp extends around the swamp and along its marshy outlet to the Tippecanoe River. Below the outlet two moraines approach the river from each side and show indications of being cut by water at their ends. It seems probable that these and possibly other moraines were continuous immediately after the glacial recession, while the Tippecanoe drainage basin was being established. This would have caused a large irregular area, including the area described, to be under water.

The Second Lake.—When these larger moraines were cut in two this lake was lowered to the level of a moraine, extending across its outlet and nearly parallel to the Tippecanoe River. The outline of this lake can be pretty accurately traced by the dark peaty soil and the sedges which still grow in what was the shallower part of it.

The Third Lake.—The erosion of the outlet tended to lower the water-level of the lake while constant deposition of plants that grew and died around the margin tended to bring the lake floor nearer the surface. These processes eventually resulted in limiting the lake to the much deeper "kettlehole" in the northern part of the area described. The kettlehole is the region occupied by the present swamp.

The outlet of this lake was not through a narrow moraine, as had been the outlet of the lake at higher levels, but through a channel one mile in length, whose slope was very slight.

By a series of excavations on the west side of the swamp it was determined that the slope of the sand under the peat for the first eighty-two feet, beginning at the peat margin was one in ten; that is, for every

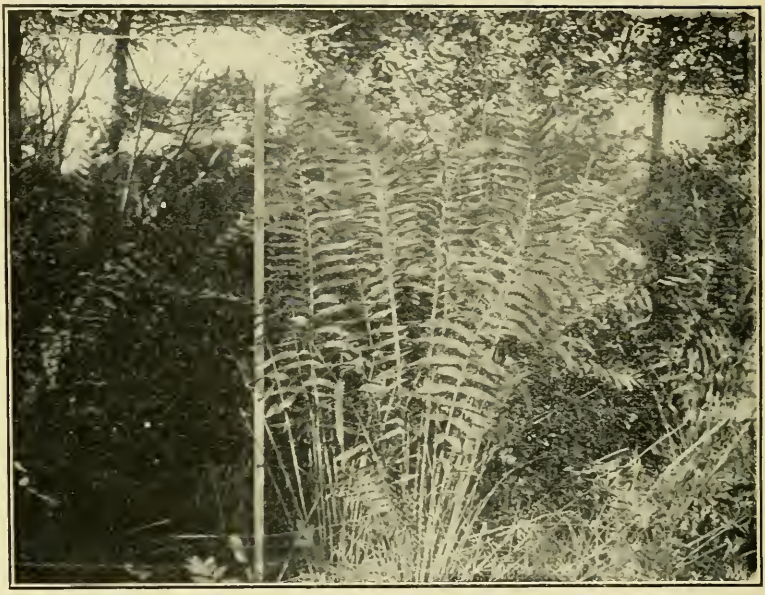

Fig. 4. Cinnamon ferns with scale. Spaces = 1 foot.

advance of ten feet toward the center of the swamp there was an increase of one foot in the depth of the peat. If this slope continues to the center, a depth of 117 feet would be attained. The evidence cited does not prove that the slope is so uniform nor that the depth mentioned did exist, but approximately such a depth is probable.

Here was a lake of considerable depth surrounded by a very level plain (the older lake bottom), with an outlet over a mile in length, and with shores of slight slope. What was the cause of its extinction?

Fig. 6. Drosera intermedia.

Description of the Swamp Proper (Fig. 1).—The drainage lines of the swamp begin at the northwest corner and extend around near the margins to the southeast corner. The central part is slightly elevated above the remainder.

These facts indicate that the plants are more vigorous in the center than near the margins. This elevated portion has in its center a U-shaped area of tamaracks (Larix Americana), with the open end of the U pointing northward. Most of this northern opening has been due to artificial disturbance. The primary drainage-lines are on the east and

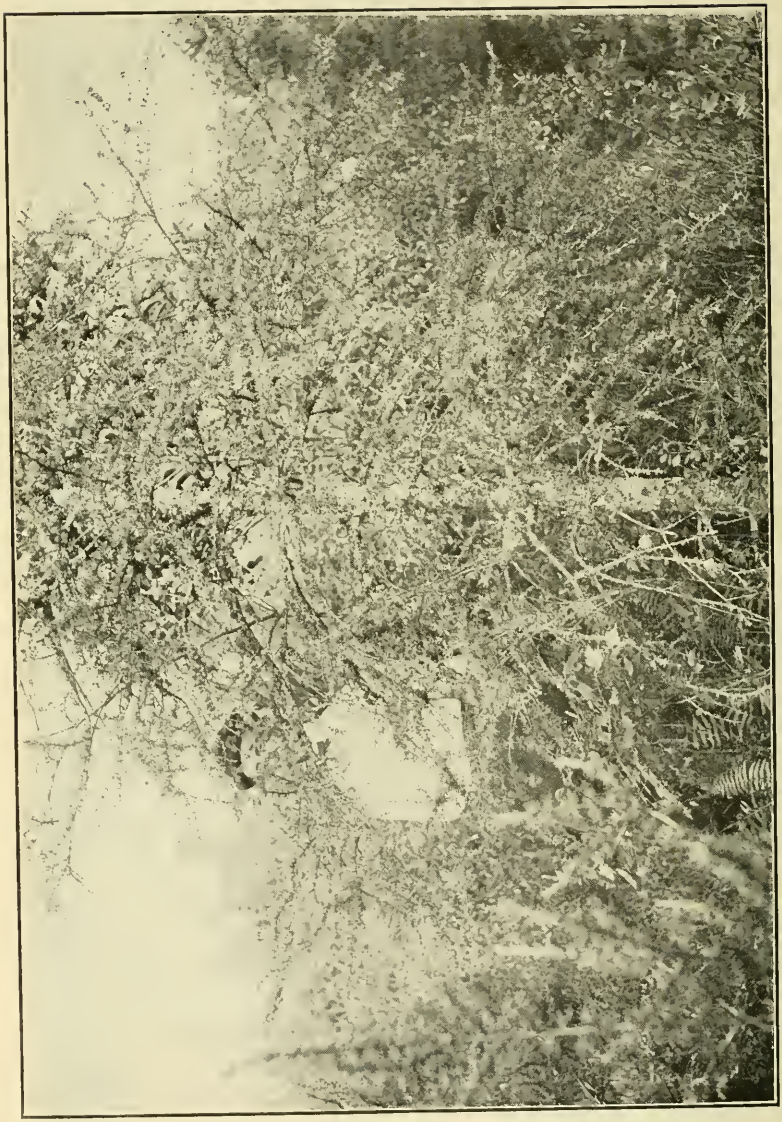

Fig. 7. A lichen-covered tamarack.

south. On these sides the slopes are more abrupt. This has a very marked effect upon the flora.

The flora may be divided into four regions: (1) The tamarack area, (2) the west and north slope, (3) the south slope, (4) the east slope.

The tamarack area has many individual plants but few species. The tamaracks are very dense except in the southwest part. Mingled with these are poison sumachs (Rhus venenata), dwarf birch (Betula Americana) and huckleberry (Gaylussacia resinosa). The ground is covered with sphagnum, much of which is arranged in its characteristic hassocks. (Fig. 2.) Growing from among these hassocks and probably assisting in forming them are ferns (Osmunda cinnamomea), Figs. 3 and 4. Near the margin this fern is replaced by the Royal fern (O. regalis). Mingled with the sphagnum are pitcher plants (Sarracenia purpurea) (Fig. 5) and Drosera (Fig. 6). D. intermedia being the most abundant in the southern partion and D. rotundifolia in the northern part. As the dryer marginal regions are approached sphagnum is replaced by such mosses as Polytrichium, Leucobryum and Dicranum. In the slightly shaded portion two species of orchids were found (Calapogon pulchilla, and Cypripedium spectabile).

In the eastern part the boles of the tamaracks were covered with Parmelia, but in the southern and western part these were replaced with Cetraria aleurites and Usnea barbata of such vigorous growth that they often cover the branches to their tips and envelope the chlorophyl tissue (Fig. 7). Coincident with this is the death of the tamarack, but whether there is a cause and effect relation between these phenomena and, if such a relation exists, which is cause and which effect has not been determined.

Under this growth excavations showed that there was a great depth of pure peat. Many of the plants composing this peat were well preserved. It was possible to identify some of them as being of the same species as some of the living forms now growing above this accumulated debris.

The West Side.—At the south end of the west side, is a rail fence. Along this fence has crept in maples (Aces rubrum), poplars (Populus tremuloides), and a few elms (Ulmus Americana). This fence, as all artificial things seem to do, disturbed the natural sequence of plants. As a result of this disturbance, just north of it occurs a great variety of plant life, which, as one passes to the north, is differentiated into three well defined zones (Fig. 8). The inner is dominated by the poison sumach

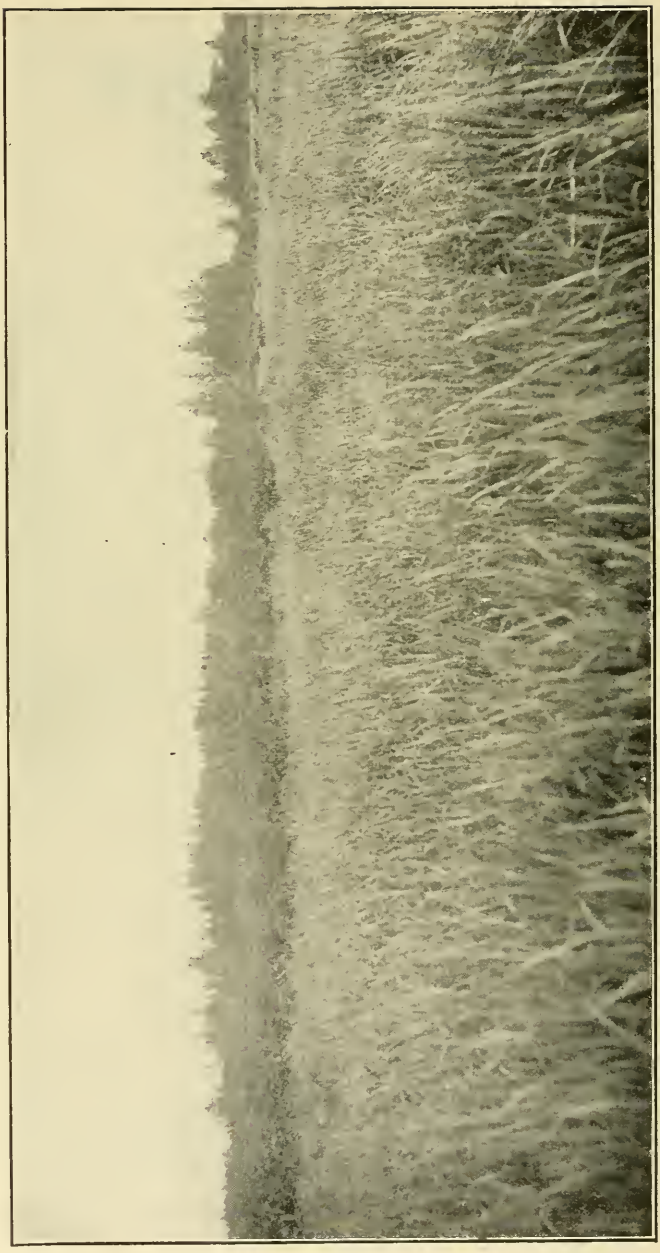

Fig. 8. The three zones on the west side.

(Rhus venenata), the second by blue flag (Iris versicolor) and the third by sedges. The Rhus belt contains a very little sphagnum, a few pitcher plants, and some droseras. These are plainly remnants of a condition similar to that which maintains at present in the tamarack area. Besides these there are sedges (Eriophorum Virginianum), swamp bellflower (Campanula aparionoides), and a few mints (Mentha Canadensis, and Lycopus sinuatus).

The Iris Zone.—The blue flag (Iris versicolor) gives the color to this zone, but there are nearly as many individuals of marsh shield fern (Asplenium thelypteris) and bonset (Eupatorium perfoliatum) as of Iris. These were the predominant plants, but there appeared a smaller number of goldenrods (Solidago Canadensis), meadow sweet (Spirea salicifolia), trow-weed (Vernonia Noveboracenous), horse-mint (Monardo fistulosa) agrimony (Agrimonia pariflora), and vervain (Verbena hastata). The mints and composites seem to be the most prominent among the forerunners of mesophytic life. Outside this was a fragment of a sedge belt. This contained coarse sedges and grasses (Scirpus atrovirens S. microcarpus, S. cyperinus, Panicum Crus-galli) and a few composites.

The north side (Fig. 9) is like the west except that there is no sedge zone, the Iris of the east end is replaced by calamus (Acorus calamus), and the Rhus almost disappears as the eastern extremity is approached. Two species, however, should be noted. On the inside of the Rhus zone two individuals of thistle (Cnicus lanceolatus) were found. These are, as it were, the extreme advance guards of xerophytic conditions. About the center of this zone, several individuals of Sagittaria (Sagittaria variabilis) in a healthy condition were found. So far as I am able to discover, this plant is never introduced except in water. This means that this plant has been able to survive the changing conditions from lake margin to Rhus belt by gradual adaptations. These plants were much smaller and contained less chlorophyl than plants of the same species growing in water at the same latitude.

The South Side.—The south side contains one of the primary drainage lines. Along this an open ditch has been dug. The willows (Salix nigra, S. alba, S. discolor, S. tristis, S. lucida, S. cordata) follow the ditch throughout its entire length. Near the east end the roses (Rosa Carolina) form a belt reaching from the deciduous forest trees on the south to the tamaracks on the north. North of the ditch they follow the ditch to its western extremity, but the zone becomes narrower. Toward the west a

Fig. 9. The north side, looking south.

zone of Iris occurs on each side of the willows. Wherever Rosa occurs Spirea abounds. Spirea tomentosa on the east side and Spirea salicifolia on the south side. Along the damper parts of this area grow Polygonum sagittatum, P. parvifolium, P. hydropiperoides, Epilobum strictum, Plantago pusilla, Galium trifida, Panthorum sedoides, and Alisma plantago. There is a fine carpet of false purslane (Ludwigia palustris) over the entire area.

The ditch itself contains water only in times of flood. Notwithstanding this it is almost covered with floating forms of liverworts (Riccia finitans, Ricciocarpus natans). Yellow wated lilies (Nuphur advena) grow in it for more than half its length.

At the west end, there is a sort of bay that has recently been fairly well drained. This has resulted in the introduction of a great variety of species. Most of those found further east along this side persist. In addition occur: Eupatorium perfoliatum, purpureum, Helianthus annuus, Solidago Canadensis, Bidens chrysanthemroides, Pycnantheum lanceolatum, Mentha Canadensis, Lycopus sinuatus, Virginicus, Potentilla argentea, P. parviflora, and Verbena hastata. It is a fine example of confusion of species during a change of conditions.

The East Slope (Fig. 10).—On the east side there is a row of willows near the margin. Inside this there is a broad zone of roses (Rosa Carolina), in which is mingled poplars (Populus tremuloides), swamp oaks (Quercus tinctoria), and elms (Ulmus Americana).

General Remarks and Conclusions.

First.—On account of the great depth of the peat and the slope of the underlying sand we may conclude that this swamp was a lake which has been filled with vegetation, and that the process still continues.

Second.—That in recent years the growth has been most rapid in the center of the swamp, thus elevating it and forcing the drainage lines to the margins. This was made possible through the inhibition of the processes of decay so often noted in sphagnum swamps.

Third.—The fact, that there are no peaty remains on the level plain surrounding the present swamp, indicates that the first lake was a very ephemeral one. When a topographic form exists for a short time its effect upon the flora is so slight that an interruption may be caused in the usual succession of plant life. An excellent illustration of this fact has been observed in connection with these studies in the case of Little Eagle

Fig. 10. The east side, looking south.

Lake, Kosciusko County, Indiana. Here the lake level has been lowered so rapidly that a meadow is developing without the usual intervening marginal swamp life.

Fourth.—Two additional comparative notes should be added. At the west end of Turkey Lake is a kettlehole which exhibits the early stages of the process. In parts the lake has been filled to the surface with plant remains. In some places the advance into deeper water is being made along the surface, so that a shelf of plant life exists with

Fig. 11. Kettlehole north of Eagle Lake.

very little beneath it except vegetable debris and water. The plant which contributes most to this is swamp loosestrife (Decodon verticillatus). It is soon assisted by sedges and willows, so that the zone which contains Decodon only is very narrow.

North of Eagle Lake is another kettlehole (Fig. 11), which exhibits the latter part of the process. The circular flat basin filled with peat and surrounded by moraines indicates clearly its origin. The water content of the soil would indicate mesophytic conditions. However the central part of this area is occupied by tamaracks. This affirms the proposition of Cowles that the change in topography may outstrip the co-ordinate modifications of plant societies.

Many more comparative studies will be required before each step in the process can be described in detail. All the conditions necessary for the formation of a tamarack swamp can not now be stated, although two are apparent (1) a relatively deep lake; (2) the destruction of this lake by plant deposition, for this alone can produce the proper substratum for the introduction of the tamarack.

A list of the orders of plants and the species in each found in the Leesburg Swamp:

1. NYMPHÆACEÆ.
   Nuphar advena.

2. SARRACENIACEÆ.
   Sarracenia purpurea.

3. GERANIACEÆ.
   Impatiens biflora.

4. ILICINEÆ.
   Ilex monticola.

5. SAPINDACEÆ.
   Acer rubrum.

6. ANACARDIACEÆ.
   Rhus venenata.

7. ROSACEÆ.
   Spirea salicifolia, S. tomentosa, Rosa Carolina, Potentilla Canadensis, P. argentea, Rubus hispidus, Agrimonia parviflora, Prunus Americana, Pyrus coronaria.

8. CRASSULACEÆ.
   Penthorum sedoides.

9. DROSERACEÆ.
   Drosera rotundifolia, D. intermedia.

10. ONAGRACEÆ.
    Epilobium strictum.

11. CORNACEÆ.
    Cornus Canadensis, C. florida, C. sericea, C. stolonifera, C. paniculata, Nyssa sylvatica.

12. CAPRIFOLIACEÆ.
Viburnum prunifolium, Sambucus Canadensis.

13. RUBIACEÆ.
Galium trifida, Cephalanthus occidentalis.

14. COMPOSITAE.
Vernonia noveboracensis, Helianthus annuus, Solidago Canadensis, Bidens chrysanthemoides, Eupatorium perfoliatum, E. purpureum, Cnicus lanceolatum.

15. LOBELIACEÆ.
Lobelia cardinalis.

16. CAMPANULACEÆ.
Campanula aparinoides.

17. ERICACEÆ.
Gaylussacia resinosa, Vaccinium macrocarpum.

18. VERBENACEÆ.
Verbena hastata.

19. LABIATÆ.
Scutellaria gulriculata, Monarda fistulosa, Pycnanthemum Virginiana, Mentha Canadensis, Lycopus Americana, L. virginicus.

20. PLANTAGINACEÆ.
Plantago elongata.

21. POLYGONACEÆ.
Polygonum sagittatum, P. hydropiperoides, P. arifolium

22. LAURACEÆ.
Sassafras officinale.

23. UTRICACEÆ.
Ulmus Americana.

24. JUGLANDACEÆ.
Carya alba, C. microcarpa

25. CULPULIFERÆ.
Quercus alba, Q. macrocarpa, Q. bicolor, Q. rubra, Q. tinctoria, Q. palustris, Q. imbricaria, Q ilicifolia, Betula pumila, Corylus Americana.

26. Salicaceæ.

Salix amygdaloides, S. alba, S. discolor, S. nigra, S. tristis, S. rostrata, S. lucida, S. cordata, S. humilis, S. longifolia, Populus tremuloides, P. grandidentata.

27. Coniferæ.

Larix americana.

28. Iridaceæ.

Iris versicolor.

29. Araceæ.

Acorus calamus.

30. Alismaceæ.

Alisma plantago, Sagittaria variabilis.

31. Cyperaceæ.

Scirpus atrovirens, S. microcarpus, S. cyperinus, Eriophorum Virginianum.

32. Graminæ.

Panicus Crus-Galli.